

Can the STAR protocol generalize effectively? Initial clinical results in New Zealand and Hungarian ICUs

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INTRODUCTION

Background: ICU patients often receive glycaemic control to mitigate the negative effects of prolonged hyperglycemia. However, results of glycaemic control protocols have been mixed. Quality and consistency can be variable, leading to sub-optimal outcomes due to both patient-specific and external factors. In particular, intensive insulin therapy can lead to risk of iatrogenic hypoglycemia.

Objective: To report initial clinical results of the STAR glycaemic control protocol at an independent intensive care unit (ICU) in comparison to its first implementation.

METHODS

15 pilot episodes (1168 hours) using STAR at Kálmán Pándy Hospital (Gyula, Hungary) are directly compared to 38 episodes (3763 hours) in Christchurch Hospital. Only patients with a target range of 4.4 - 8.0 mmol/L were included. Performance is assessed by percentage of (hourly re-sampled) BG measurements in glycaemic bands. Safety is assessed by numbers of patients with severe hypoglycaemia (BG < 2.2mmol/L) and degree of mild hypoglycaemia (%BG<4.0mmol/L). Clinical effort is assessed as average BG measurements per day.

Gyula administers insulin as constant infusions, and STAR actively controls both enteral and parenteral nutrition inputs. Christchurch uses insulin boluses, and STAR actively controls enteral nutrition (parenteral nutrition is clinically determined). Measurements were 1-3-hourly, with available intervals determined by STAR, and chosen by nursing staff.

STAR determines optimal combinations of nutrition and insulin by identifying patient-specific insulin sensitivity (SI), and using stochastic forecasting to predict how patient condition is likely to change over the next 1-3 hours.

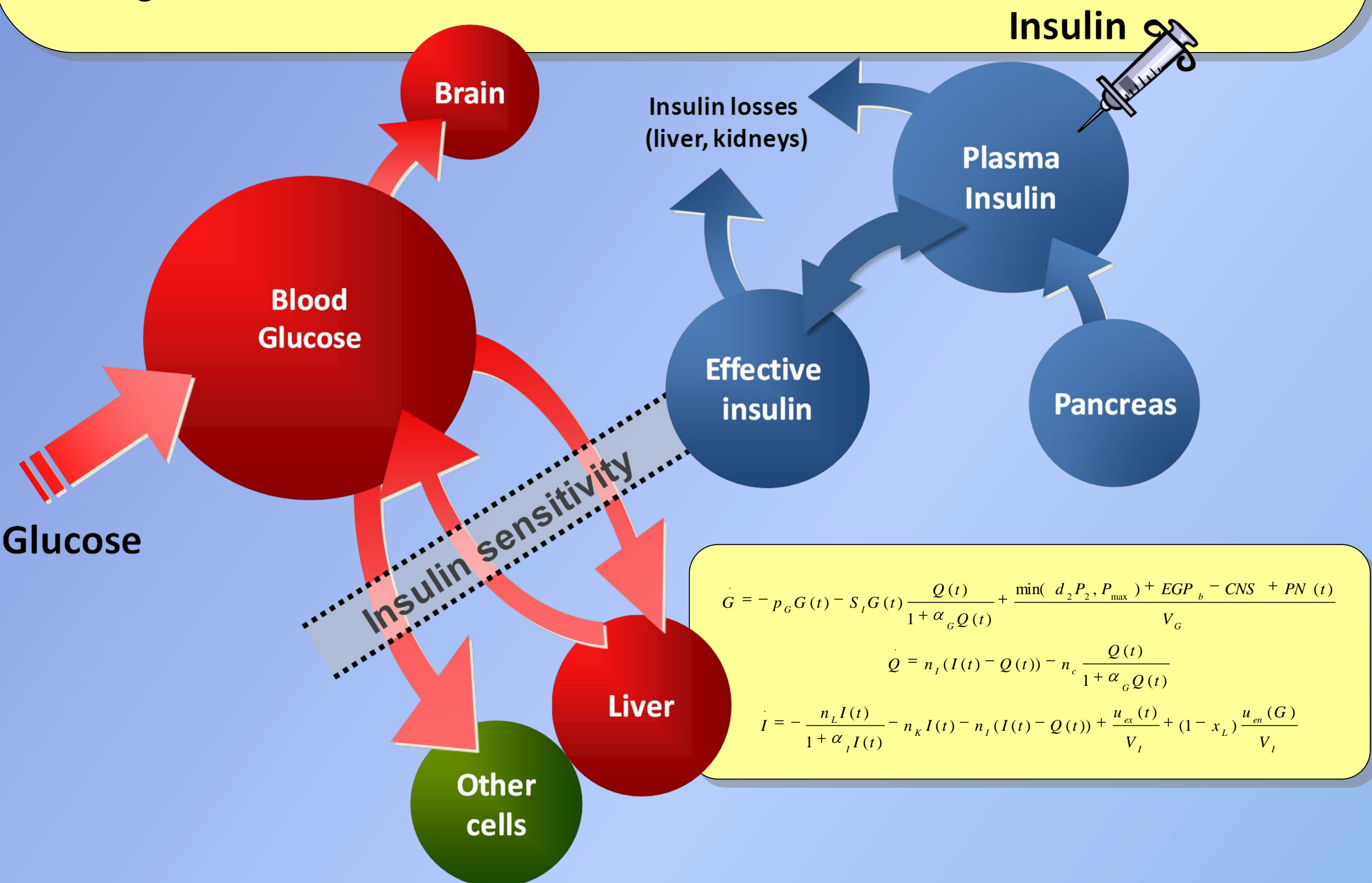


Figure 1a - above: A schematic of the ICING model used to generate BG predictions with STAR.

Figure 1b - left: STAR is run on a tablet by the bedside (pictured).

RESULTS

STAR was able to target BG to an equivalent level in two distinct ICUs, with cohort BG at 6.0 [5.4 - 6.8] mmol/L (Gyula) and 6.1 [5.6 - 6.8] mmol/L (Christchurch). Effort was similar (12.3 and 12.8 measurements/day in Gyula and Christchurch, respectively).

Gyula performance/safety: 72.7% and 80.43% of BG in 4.4-7.0 and 4.4-8.0mmol/L bands and 2.2% BG<4.0mmol/L. Christchurch performance/safety: 77.8% and 89.43% of BG in the 4.4-7.0 and 4.4-8.0mmol/L bands and 0.87% BG<4.0mmol/L. There were no severe hypoglycemic events during STAR in either ICU.

Performance differences were due to 1 Gyula patient without whom all metrics were within 0.1-1.0% difference. Insulin and nutrition inputs were comparable, with Gyula patients receiving increased nutrition inputs due to clinical practice.

BG distributions in Christchurch were markedly similar to those predicted by virtual trials.

Table 1: Summary table of results from the clinical trial. Overall, the results show high control performance and low clinical effort, with safety preserved and no patients experiencing episodes of severe hyperglycemia.

	Christchurch	Gyula
Patients		
Number of episodes	38	15
Hours of control	3763	1168
Workload		
# BG measurements:	1948	622
Measures/day:	12.4	12.8
Control performance		
BG median [IQR] (mmol/L):	6.1 [5.6 - 6.8]	6.0 [5.4 - 6.8]
% BG within 4.4 - 7.0 mmol/L	77.8	72.7
% BG within 4.4 - 8.0 mmol/L	89.4	80.4
% BG within 8.0 - 10.0 mmol/L	6.1	10.0
% BG > 10.0 mmol/L	3.0	2.2
Safety		
% BG < 4.4 mmol/L	1.54	4.85
% BG < 4.0 mmol/L	0.87	2.43
% BG < 2.2 mmol/L	0.0	0.0
# patients < 2.2 mmol/L	0	0
Clinical interventions		
Median insulin rate [IQR] (U/hr):	3.0 [1.5 - 4.5]	2.5 [1.0 - 4.5]
Median [IQR] enteral nutrition rate (g of carb/hr):	4.9 [0.0 - 6.1]	4.4 [2.4 - 5.5]
Median [IQR] parenteral nutrition rate (g of carb/hr):	0.0 [0.0 - 0.0]	3.4 [1.6 - 4.2]

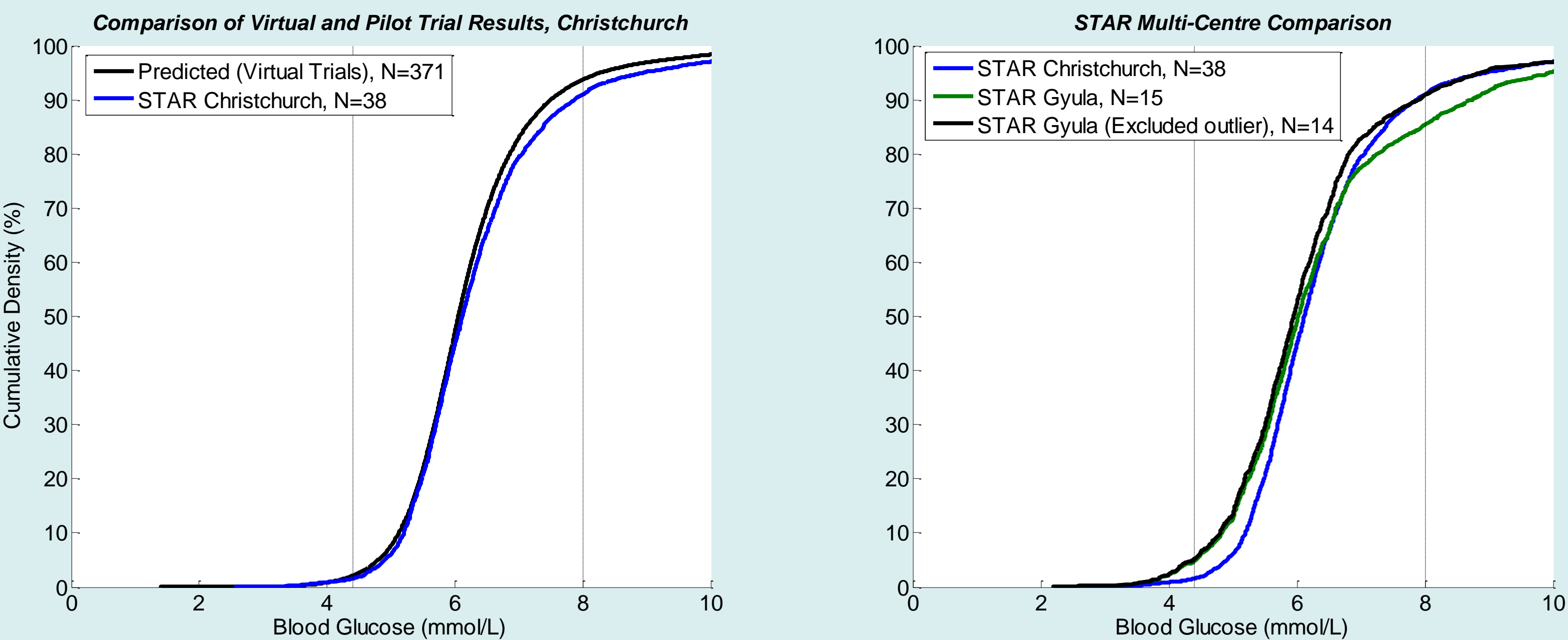


Figure 2: BG cumulative density functions from Christchurch Pilot trial and virtual trials using the N=371 SPRINT cohort (LHS). These two curves are remarkably similar, showing good agreement between the predicted and observed results in a single ICU. BG distributions from STAR Christchurch and Gyula are overlaid (RHS), showing the transferability of the STAR protocol. Removal of a single outlier patient makes a dramatic difference to Gyula results.

CONCLUSIONS

STAR was equally effective in two ICUs, across geographically distinct clinical units, patients, and clinical practice. No significant difference was seen using infusion or bolus insulin. The STAR framework was readily transposed and quality glycaemic control was achieved.

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